DECLARATION

I, Frederick R. Warren-Boulton, declare under penalty of perjury that the foregoing is true and correct. Executed on February 14th, 1997.

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Statement of Dr. John R. Norsworthy[1]

RESPONSE TO CHRISTENSEN'S ASSOCIATES' "CRITIQUE OF AT&T PERFORMANCE-BASED MODEL" AND TO STRATEGIC POLICY RESEARCH'S "THE DEPRECIATION SHORTFALL"

Appended to the USTA Comments in the FCC's Access Charge Reform

proceeding, CC Docket No. 96-262, are two attachments containing criticisms and comments on

the methods followed in the Performance-Based Model, submitted in the LEC Price Cap

Performance Review (X-Factor) proceeding, CC Docket No. 94-1. These two attachments are:

the "Critique of AT&T Performance-Based Model," by Christensen Associates, and "The

Depreciation Shortfall" by Strategic Policy Research. I deal with both of these papers in this

Statement.

      1.   The major part of this Statement responds to matters raised by Christensen

Associates in its "critique" of the Performance-Based Model ("PBM"). In its paper Christensen

Associates offers several arguments allegedly criticizing the PBM. They address (i) the PBM's

separate estimate of interstate total factor productivity ("TFP"), (ii) its allocation of capital costs,

(iii) its extrapolation of data within the 1985-1994 period, and (iv) several methodological

practices embodied in the PBM's calculations. On this basis, Christensen Associates takes

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[1]   Dr. Norsworthy authored and co-authored statements in the LEC Price Cap Performance Review (X-Factor) proceeding before the Commission (CC Docket No. 94-1), and his background and qualifications have been set forth in attachments to AT&T's Comments filed therein.

exception to AT&T's showing that a substantially higher X-Factor should be attributed to the LECs' interstate access services.

In response, this Statement demonstrates that Christensen Associates' main arguments are unjustified. Among other things, the Christensen Associates' paper (a) deliberately ignores the vast difference between interstate TFP and TFP for all the LECs' regulated services, (b) improperly seeks to shift the discussion of Christensen Associates' misstatement of the capital share in its TFP calculation to one concerning the relationship between total revenues and total cost, and (c) implicitly criticizes procedures used in Christensen Associates' own calculations, including, inter alia, interpolation and measurement-by-proxy methods applied in its own model (the "Simplified Christensen Model") previously presented to the FCC. Finally, this Statement presents updated productivity and X-Factor data for the 1985-1995 period; these more recent data show clearly that the X-Factor for use in the price cap formula for the LECs' interstate access services recommended by AT&T is indeed a moderate one, based on the LECs' productivity performances and their recent actions electing higher productivity improvement targets than are consistent with the Christensen Associates' account of their productivity potential.

2.   In the last few pages of this Statement, I respond to the paper by Strategic Policy Research ("SPR") discussing a potential "shortfall" of FCC-allowed depreciation from economic depreciation. As part of its analysis, SPR cites the quality adjustment factor, applied in AT&T's Comments in Docket 94-1 to support SPR's contention that the LECs' capital stocks are inadequately depreciated under the depreciation rules established by the Commission. In response

to SPR, this Statement demonstrates that the quality factor is not appropriate to be used as SPR has done in its paper.

I. RESPONSE TO CHRISTENSEN ASSOCIATES

In this response, it is difficult to assess the quantitative details and effects of many of Christensen Associates' assertions because its latest spreadsheets, which have been made available, calculate productivity only through the year 1993. Consequently, Christensen Associates' references to data years 1994 and 1995 cannot be assessed completely. This is especially true of the labor adjustment accounted in line 11 of Table 1 and line 4 of Table 2 of the Christensen Associates critique. Further, whereas the PBM bases its calculations on the period 1985-1995 (earlier results were based on 1985-1994), Christensen Associates' critique applies only to the period since 1988. The PBM conforms to the Commission's dictum that the relevant period for determining the performance of the LECs is 1985 forward. We are therefore at a loss to guess what the effects of the Christensen Associates' comments would be if they were applied to the entire period of the Performance-Based Model calculations. The Christensen Associates' analysis is unenlightening on this important point. Indeed, what Christensen Associates has really done is to show the effects of including the PBM assumptions in the Simplified Christensen Model ("SCM") rather than the effects of the SCM assumptions on the PBM.

Further questions are raised by the Christensen Associates analysis because the effects in Table 1 of its critique, taken from the quantity side of the TFP analysis, are not always balanced by effects of the same magnitude in Table 2, the price side of its analysis. At a minimum,

Christensen Associates should explain why the usual duality between price and quantity in TFP analysis does not hold in its analysis.

A.   Determination of TFP on an Interstate-Only Basis

This element of the Christensen Associates critique is accounted in line 3, Table 1, p.30 of the Christensen Associates critique, attached to the USTA Comments. (Hereafter, such references to data in the Christensen Associates' critique will be abbreviated without citing the critique, for example, as "line 3, Table 1.") There are two levels of discussion of the interstate calculation of TFP: the practical and the academic. As demonstrated in the Norsworthy Statement and the Norsworthy-Berndt Reply Statement previously filed in the LEC X-Factor proceeding, the objective at a practical level is to construct a reasonable lower bound for TFP growth in the interstate services supplied by the LECs. *This practical objective differs in no way from the objective of the Simplified Christensen Model which relies on Commission-adopted procedures to allocate between unregulated and regulated services.* The objective from an academic/econometric perspective is to use an estimated multiple output model of production for the LECs and to test for separability of regulated from unregulated output (as in the Simplified Christensen Model) and for separability of interstate output from other outputs (as in the Performance-Based Model). *This academic/econometric objective also differs in no way from that of the Simplified Christensen Model, which distinguishes between the LECs' unregulated and regulated services.* Both AT&T and USTA (Christensen Associates) have acknowledged the difficulty in estimating stable econometric models of production, and no such estimates have been presented for consideration in this proceeding or in the X-Factor proceeding. Thus, there is no

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econometric support for either contention: that the regulated and unregulated outputs of the LECs are or are not separable, or that interstate and intrastate outputs of the LECs are or are not separable.

In the absence of econometric evidence, in formulating the Performance-Based Model we chose to examine the available quantitative information to assess the properties of a lower bound for interstate TFP growth. Based on the evidence derived from the jurisdictional separations data, it was concluded that a reasonable lower bound can be constructed. That lower bound is calculated in the PBM.

By contrast, there is no empirical evidence whatsoever, cited by Christensen Associates, USTA or the LECs, that supports the construction of a TFP for the LECs' regulated services separate from that for their unregulated services, despite the fact that unregulated services have grown much more rapidly in recent years. These broader objectives of TFP analysis should not be neglected, as we focus on some of the comments on separately measuring TFP growth for the LECs' interstate access services.

In its critique Christensen Associates questions any estimation of service-specific TFP growth based on the FCC's cost allocation rules. It continues to deny the existence of any service-specific TFP growth for interstate access service, while ignoring the parallel argument embodied in Christensen Associates' own measure of TFP for regulated, as separated from unregulated, services. This separation is also based on the FCC's cost allocation rules, which

must be applied in that case as well to capital and other inputs that are common to regulated and unregulated inputs. Christensen Associates offers no empirical evidence to support its claim that service-specific TFP growth is not meaningful for the multi-service LECs. To support the argument implied by its model, it would first need to show that common costs truly exist in the provision of interstate access service and other regulated LEC services, and that no such common costs exist between regulated and unregulated services. In other words, Christensen Associates would need to test the jointness of production in an econometric model of production.

Standard tests are available to determine the jointness of production both globally and locally. Using econometric estimation procedures and standard tests, one could in principle test the jointness of production at least locally if not globally (if information about stand-alone costs were not available) for LEC services. Plainly, Christensen Associates has not carried out such tests. Moreover, there are no publicly available data that would support such tests. It is not at all evident that, even if such tests were performed, the results would be both unambiguous and sufficiently important quantitatively to justify a clear decision for or against cost separability of regulated from unregulated. Finally, Christensen Associates offers no solution to the problem of measuring TFP for interstate services, preferring to advocate a clearly low TFP and an X-Factor that contains no adjustment for differences in input prices. In order to do so, it must ignore many of the recent advances in productivity measurement and in regulatory theory published in the last two decades (as pointed out below). There is no basis for Christensen Associates to characterize conformance with these advances as "errors".

Even without formal testing, however, it is clear on the basis of the general characteristics of providing telecommunications services that there is substantial sharing of inputs, particularly capital, between interstate and intrastate services and that therefore common costs exist among the different regulated services provided by the LECs. Furthermore, there is general agreement that (a) interstate output has grown faster than intrastate output, and (b) interstate access services are produced primarily by shared capital inputs rather than by more readily separated labor and material inputs. Given these conditions, it would be both unwise and ultimately unworkable to apply the TFP growth for all LEC regulated services to determine the TFP growth for interstate services alone. Such an approach is manifestly incorrect, would produce seriously biased results, and would dramatically slow the emergence of competition.

Because the Commission is applying price cap regulation to the LECs' interstate access services, then clearly the relevant task is to estimate TFP for those services on an interstate basis only. Patently, the TFP growth for all LEC regulated services (combining both intrastate and interstate) is not a reasonable approximation of TFP growth for interstate services alone. That the precise answer cannot be obtained by a particular method is no argument for the use of an alternative that is *known to be wrong, and to be strongly biased downward.* To apply price cap regulation to interstate access service (one of many services produced by the LECs), some methodology that provides a reasonably approximate measure of the TFP growth for the interstate access services must be used. This approximate measurement of TFP growth can then be used in calculating the X-Factor in the price cap equation for the LECs' interstate access services, as is done in the Performance-Based Model.

One possible method would be to develop a measure based exclusively on data derived from the FCC's presently existing allocation rules for separating investment and operating costs between the interstate and state jurisdictions. However, the history of the evolution of the jurisdictional separations procedures suggests that there would need to be substantial adjustments of such data. Another, more reliable, procedure would be to use the methodology proposed by Dr. Norsworthy and Dr. Ernst Berndt in the X-Factor proceeding.

Because Christensen Associates criticizes both of the possible methods mentioned above, it should offer an alternative proposal to measure the interstate access service-specific TFP growth of the LECs. Instead, it argues that the FCC should use TFP growth for the LECs' total regulated services to determine the interstate access service-specific X-Factor in the LEC price cap equation. It advocates this approach without any defense of its appropriateness and without any recognition of its bias. There is no reason to believe that Christensen Associates' biased approach will increase the price efficiency of LEC interstate access regulation. Indeed, raising the LECs' price caps -- which clearly would result from using the TFP for all their regulated services -- would surely reduce pricing efficiency. In fact, it is significant that most of the LECs have recently elected to use X-Factors significantly higher than those resulting from application of Christensen Associates' approach. Even so, those LECs have enjoyed relatively high earnings levels on their interstate services. Does Christensen Associates have information concerning the access costs of the LECs about which the LECs themselves are ignorant? If it may be assumed that the LECs have acted in their own best interests by choosing much higher target X-Factors than calculated by the Simplified Christensen Model, then evidence from the LECs' own actions

discloses that adoption of the Christensen Associates approach would lead to more inefficient production processes and inefficient pricing rules.

In criticizing the PBM's measure of interstate output, Christensen Associates asserts in Exhibit 3, p. 27 of its critique that the quantity index used for special access lines is incorrect, the effect of which is not accounted in its Table 1 or 2. Christensen Associates is in error. The number of special access lines, not minutes of use, is utilized in the PBM as the quantity measure associated with special access revenues. The omission of miscellaneous services from the measure of output, accounted at line 5, Table 1 was based on our judgment that it would be quite difficult to deflate adequately the composite of services subsumed in that category. We wait with interest to see an adequate treatment of that category by Christensen Associates, and, if its methodology appears reasonable, we will adopt it. In the alternative, the revenue associated with miscellaneous output was deflated by the price index for the other components of output.

B.   The Relationship Between Total Revenue and Total Cost

In this section, I review the core of the issue confronted by the treatments of capital costs in the Simplified Christensen Model ("SCM") and the Performance-Based Model ("PBM"). The effect of this difference is accounted in line 4, Table 1 and line 2, Table 2. In all of its submissions to the Commission since the issue was raised, Christensen Associates has chosen to ignore or distort the clear evidence that its approach does not use the costs levied on ratepayers.

The fundamental difference between the Christensen Associates assumed return-to-capital treatment used in the Simplified Christensen Model, and the actual return-to-capital treatment used in the Performance-Based Model can be illustrated by examining the revenues and costs of the firm. *The Simplified Christensen Model does __not__ allocate all of the revenues of the LECs to inputs.* In particular, the allocation of revenues to capital in the Christensen Associates model may exceed or fall short of the actual return to capital realized by the LECs. Nor is there any reason to believe that the LECs' actual rates of return will equal Christensen Associates' assumed rate of return on average during any time period.

By contrast, the Performance-Based Model computes the rate of return by allocating all revenues received by the LECs to the three categories of input: labor, materials, and capital. This procedure in the Performance-Based Model conforms to the economic theory of enterprise productivity operating in the short- or long-run, and further conforms to the reality of the telecommunications industry, namely, that the enterprise is residual claimant to the revenues paid by its customers after all payments are made to its suppliers. What makes the inherent distortion in the Simplified Christensen Model so serious is that the only point at which overall costs and capital costs of the LECs enter the regulatory process under the LECs' price cap regime is through the TFP measure embedded in the X-Factor in the Price Cap Index (PCI) formula.

1. Christensen Associates' Unreliable Treatment of Capital.

A fundamental and critical assumption in the Christensen Associates' model is that capital inputs are adjusted at all times to cost-minimizing levels. This is an unsound and

unrealistic assumption, as Dr. Christensen himself has acknowledged in the past. The rapid pace

of technological change in telecommunications, and the dynamic environment in which the LECs

have operated since the Bell System divestiture, including the change-over from rate-of-return to

price cap regulation, are well recognized. There is no evidence that the capital stocks of the

LECs are completely adjusted at all times to cost-minimizing levels. Other methods for measuring

TFP are available that avoid Christensen Associates' questionable assumption. It is surprising that

the SCM depends on such weak methods.[2] The effects imputed to these differences occur in lines

8 and 9 of Table 1 and lines 3 and 6 of Table 2.

A refined appraisal of the proposition implicit in the SCM would require an

econometric model based on the variable cost function of the sort pioneered by Dr. Christensen

and his colleague, Professor Randall Brown, in a paper published in 1981. In the absence of

evidence from such a model, it is possible to examine suggestive evidence for the proposition. If

the rate of return varies through time, we would expect to see the capital stock adjusting to that

variation immediately in annual data, or at most with a short lag. Thus, if we plot the return to

capital over time, along with the level of the capital stock, we expect to see more variation in the

capital stock than in the return to capital. In order to adjust for possible biases introduced by

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[2]   It is notable that in his earlier work in collaboration with Professor Randall Brown, Dr.
Christensen argued against the assumptions that underlie the SCM: "An important
assumption that underlies most cost function applications is that all inputs are in full static
equilibrium. *In many instances, however, the assumption of full static equilibrium is
suspect and hence so are the empirical results....* Furthermore, departures from full static
equilibrium may result from factors other than internal adjustment costs. *For example,
regulatory restrictions may hinder capital mobility.*" (Brown and Christensen, 1981,
p.208) (Emphasis added.)

regulatory changes in the depreciation reserve, we computed and plotted the return per unit of

capital stock both on a gross basis and on a basis net of depreciation. When we did so, it became

immediately clear that the gross return to capital varied considerably more than the capital stock.

This finding is strong evidence against the Christensen Associates assumption that the capital

stock adjusts fully in all time periods, or even nearly so. The variation in the returns computed

both ways are considerably greater than the variation in the capital stock. This relationship is

shown clearly in Chart A below, presenting data for the 1985-1994 time period.[3] The variation in

the gross return to capital, whether or not depreciation is included, is considerably greater than

the variation in the capital stock itself, and this result strongly supporting the assumption of the

PBM that the capital stock is *not* adjusted annually to a long-run equilibrium level.

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[3]   The data underlying the calculations reported in Chart A were taken from the
        Performance-Based Model submitted to the Commission in January 1996.

Chart A

Comparison of Variation in Capital Stock and in Return to Capital for Seven RBOCs, 1995-1994, Measured by Coefficients of Variation

	Capital Stock	Return to Capital	
		Depreciation Included	Depreciation Excluded
Ameritech	1.94%	21.71%	25.93%
Bell Atlantic	6.47%	27.94%	42.73%
BellSouth	3.82%	17.95%	16.32%
NYNEX	2.15%	27.74%	25.31%
PacTel	3.33%	22.11%	33.66%
SBC	3.32%	7.17%	15.82%
US West	6.06%	20.81%	20.80%
All RBOCs	1.91%	18.27%	18.81%

As pointed out by AT&T and Dr. Norsworthy in previous submissions in the X-Factor proceeding, a desirable consequence of adopting a performance-based approach for measuring the return to capital, and for computing TFP and the input price differential, is that it reduces the sensitivity of the X-Factor to measurement of capital input. When the total revenues and the labor and material expenses are given for a sequence of years, the quantity of the capital stock can be used to separate the capital expense into price and quantity components. Under these circumstances, changes in the deflation of capital or in the rate of depreciation will change the separation of capital input into price and quantity components, but the product of the price and quantity of capital input (the total capital expense) will remain unchanged. Consequently, the weight assigned to the *capital input* in the *TFP calculation* remains unchanged, as does the

weight assigned to the *price of capital* in the calculation of the *input price index*. Thus, for example, an increase in the computed capital stock that arises from a quality adjustment will be offset by a corresponding decrease in the price of that capital input that is assessed to the ratepayers. Measured TFP will decline because the capital input is greater than before the adjustment for quality. The measured index of input prices will also decline because the price of capital input is lower, thus increasing the input price differential. The change in TFP will thus tend to be offset by a change in the input price differential, thereby resulting in a very small (or zero) effect on the X-Factor.

The Simplified Christensen Model is more sensitive, than is the Performance-Based Model, to mismeasurements of quality change, because the SCM's assumed long-run user cost of capital is determined exogenously. That is, in the SCM the price per unit of the capital input is fixed from outside the model itself, without reference to the cost of capital levied through the access rates charged to customers. Consequently, if the quantity of capital is increased by a quality adjustment, the cost of the capital input rises proportionately. Thus, the computed TFP in the SCM will be lower for two reasons: its quantity of capital is higher, and the weight assigned to capital in the computation of total input is larger. The effect on the input price index is to increase the weight of the price of capital input, but that price itself remains unchanged. There will be no direct offset in the measured input price differential related to the lower TFP. Therefore, the net effect under Christensen Associates' approach generally will be to reduce the calculated X-Factor, because the decline in TFP is not offset by an increase in the input price differential.

2. The Simplified Christensen Model's Failure to Allocate All Costs to the Inputs.

It is important to note that the only point at which the costs of production enter the LECs price cap index formula is in the TFP calculation. Thus, any costs that are omitted from the TFP calculation are not accounted for anywhere else, and accordingly would be ignored in the regulatory process. As noted above, the Simplified Christensen Model assigns an *assumed* cost to capital that depends on the assumption that the capital stock is fully adjusted to a cost-minimizing level. Hence, Christensen Associates' assumption understates the actual return to capital, and it results in substantial year-to-year deviations between the actual cost of capital levied on the ratepayers and the cost of capital reflected in its TFP calculation.

The difference in calculation methods between the Performance-Based Model and the Simplified Christensen Model is illustrated in Table 1 below.

Table 1. COST SHARE WEIGHTS FOR CALCULATION OF TOTAL FACTOR INPUT BASED ON ACTUAL TOTAL COST				
Performance-Based Model				
Labor Wt.	Materials Wt.	Capital Wt.	Remainder	Sum of Wts.
E_H / TC	E_M / TC	E_K / TC	0	= 1
Simplified Christensen Model (Assumed Rate of Return)				
Define $TC_{Assumed}$ = TR - Remainder				
Labor Wt.	Materials Wt.	Capital Wt.	Remainder	Sum of Wts.
E_H / TC	E_M / TC	AC_K / TC	$\neq 0$	$\neq 1$ (Total Cost Basis)
E_H / TC_A	E_M / TC_A	E_K / TC_A	0	= 1 (Assumed Cost Basis)

Wt. = Weight E_K = Property income   TC = Actual total cost
E_H = Labor expense AC_K = Assumed cost of capital TC_A = Assumed total cost
E_M = Materials expense

As shown in Table 1, the expenses allocated to labor and "materials" (i.e. all other purchased inputs) are the same for each model. The essential difference between these two models lies in their respective assignments of costs to capital. The Performance-Based Model, like the regulatory process itself, treats the difference between total revenues (TR) and labor and materials expenses (E_H, E_M) as a **gross return to capital**. Thus, in the Performance-Based Model all revenues received by the LEC are assigned to some input cost category. By contrast, the SCM's assumed rate-of-return approach presupposes a **long-term user cost** per unit of capital,

and assigns a total cost of capital, AC_K, that is the product of the quantity of capital input, K, and the long-term user cost, $p_K{}^*$, which is based on an *assumed* **rate of return**. Christensen Associates' assumed cost of capital is carried forward into its calculation of the X-Factor. Christensen Associates' long-term user cost assumes that the capital stock **is fully adjusted to a level that minimizes total cost in each period**. This assumption is based on the theoretical existence of full competition: that the markets for inputs and outputs are fully competitive. The Christensen Associates model also assumes that there are no costs incurred by the LECs in adjusting to new technologies and to deregulation of their markets. Clearly, these conditions are not met presently in the markets for telephone services provided by the LECs.

When these assumptions are not met, then as Table 1 above shows, there will be a residual in the Simplified Christensen Model. This residual may be positive or negative. If positive, it will correspond to an excess return to capital compared with the assumed long-run equilibrium user cost. In economic terms, the residual is an economic rent to the enterprise, such as that occurring in the case of monopoly.

Why should total revenues exactly equal the total costs assigned to the inputs? There are two reasons in principle: the economic theory of production requires it, and in practice, the regulatory authorities mandate it. The residual in Table 1 above is just as much a cost to the ratepayers as is the total compensation of labor and the materials expenses.

In a truly competitive market, the type of excess returns, described above, will tend to be eliminated by the entry or exit of firms. A positive residual will attract new resources to the industry, while a negative residual will cause some of the resources to be withdrawn, and to be allocated by their owners to other industries where the return is higher. Because the Christensen Associates model does not account for this residual in capital input in its calculation of TFP – the only point where the cost of capital enters the price cap index formula – there is no incentive under its approach to price cap regulation for the LECs to adjust the quantity of capital to the overall cost-minimizing level. In other words, whatever level of capital a LEC chooses to put in place **is guaranteed a normal rate of return, just as under rate of return regulation**. (This criticism has been stated repeatedly in AT&T's submissions to the Commission, but Christensen Associates has failed to address this point in any of its responses.) But under price cap regulation, the LEC gets an added bonus with the Christensen Associates TFP approach: if the residual is positive -- that is, if total revenues exceed the costs of labor and materials, plus a normal return on capital – the LEC is permitted to keep the money. There would be no incentive for the LEC to expand its capital and other inputs and move toward a cost-minimizing technology. The uneconomic uses to which these residual amounts (excess profits) may be put -- e.g., subsidizing the LEC's penetration of the long distance market and entry into the cable television market -- must also be considered in evaluating the calculation method proposed by Christensen Associates.

If, however, the Performance-Based Model for computing TFP is applied in the LEC price cap formula, then the residual – whether positive or negative – tends to be eliminated

as the LEC responds to the economic incentives in the PCI. In such a case, the price cap incentives more closely approximate those of the competitive marketplace. The effect on the PCI is the key to the LEC's incentive to adjust its costs. In the Performance-Based Model the cost of capital, like all other costs, enters the PCI through the measured X-Factor – the measure of TFP growth.

For both the Performance-Based Model and the Simplified Christensen Model, TFP is the ratio of aggregate output to aggregate input. Aggregate input is based on the sum of all purchased inputs, measured in constant performance physical units, or in real dollars of some base period adjusted to a constant performance basis. Quality change in an input then reflects changes in the performance of a unit of that input, revealed as the change in its marginal product when output, all other inputs, and the technology of production are held constant. The cost share weights in the calculation of TFP are computed as shown in Table 1 above.[4] Aggregate or total factor input is the sum of indices of individual inputs weighted by their respective shares in total factor cost.[5]

Table 2 below shows how revenues paid by customers are allocated in the Performance-Based Model and the Simplified Christensen Model. In the PBM, there is no excess

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[4]   This statement holds exactly for the Tornquist Index in the Christensen model. It is approximate to a rather high degree of accuracy in the Fisher Ideal Index used in the Performance-Based Model.

[5]   The weighting scheme that results from applying the Fisher Ideal Index to aggregate the inputs is slightly different, but the description here applies with little adjustment.

return -- no remainder -- because all revenues are allocated to some cost category. In the SCM, however, there will be a remainder that may (in principle) be positive or negative because revenues are not balanced by costs.

Table 2. ALLOCATION OF TOTAL REVENUES (TR) TO INPUT CATEGORIES			
Performance-Based Model			
Variable Costs (VC)		Allocated Return to Capital	Remainder
Labor: E_H	Materials: E_M	Capital: E_K	Excess Return
Total Compensation	Other Input Expense	TR - VC	0
Simplified Christensen Model			
Variable Costs (VC)		Allocated Return to Capital	Remainder
Labor: E_H	Materials: E_M	Capital: AC_K	Excess Return
Total Compensation	Other Input Expense	Assumed Cost: AC_K	TR - VC - AC_K

The actual total cost (TC) authorized to the LEC by the price cap regulation process is the total revenue (TR) that the LEC receives. This actual total cost is the basis for the cost shares used in the TFP calculation in the Performance-Based Model. The *assumed* total cost (TC_A) in the Christensen Associates model differs from the actual total cost, TC, by the amount of the remainder.

To understand the incentive effects of these different methods for computing the X-Factor, let us consider two situations: first, where there is a positive residual compared to the long run equilibrium, and second, where there is a negative residual. Each situation is analyzed for both the PBM and the SCM.

Case I. Positive Residual

Table 3 below shows the case where the residual is positive. The correct weight for capital under the Performance-Based Model is shown to be 0.20 in the upper panel of the table; all costs and revenues are assigned to the appropriate inputs, and there is no remainder from the total costs levied on ratepayers. The incorrect weight assigned by the Christensen Associates assumed rate of return approach in the SCM is shown in the lower panel of the table. In the case of the SCM, part of the revenues are not assigned to any input, and there is a ten percent residual from total costs levied on ratepayers. Thus, the SCM weights the capital input, and hence the growth in capital input, too low. This results in understating the total factor input, and in understating the growth in total factor input when capital growth is positive.[6] Correspondingly, in that approach, TFP and the growth in TFP – impacting the X-Factor – are overstated. Overstatement of the X-Factor leads to higher measured performance of the LEC. Use of the correct weight would lead to a lower measured performance, i.e., lower TFP and a lower X-Factor.

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[6]   This occurs when other things remain unchanged, and the growth rates of the other inputs together are approximately the same as the growth rate of capital input.

Note, however, that actual profits received by the LEC under the Christensen Associates assumed rate of return approach are higher than those credited in the cost measure that enters the price cap index formula. This characteristic of the Simplified Christensen Model allows the LEC to gain in two ways: higher actual profits under the prevailing price cap, and a smaller downward adjustment of the price cap at the end of the current period.

Table 3. SAMPLE CALCULATION OF COST SHARE WEIGHTS FOR POSITIVE EXCESS PROFITS				
Performance-Based Model				
		Actual Capital Cost: $E_K = 200$		
$E_H = 450$	$E_M = 350$	$E_K = 200$	Actual Total Cost: TC = 1000	
Labor Wt.	Materials Wt.	Capital Wt.	Remainder	Sum of Wts.
E_H / TC = .45	E_M / TC = .35	E_K / TC = .20	0	= 1
Simplified Christensen Model				
Actual Capital Cost: $E_K = 200$ Assumed Capital Cost: $E_{KA} = 100$				
$E_H = 450$	$E_M = 350$	$E_K = 200$	Actual Total Cost: TC = 1000 Assumed Total Cost: $TC_A = 900$	
Labor Wt.	Materials Wt.	Capital Wt.	Remainder	Sum of Wts.
E_H / TC = .45	E_M / TC = .35	AC_K / TC = .10	.10	= .90 (Total Cost Basis)
E_H / TC_A = .50	E_M / TC_A = .40	E_K / TC_A = .10	0	= 1 (Assumed Cost Basis)